

APPENDIX 3A

Summary of Sampling and Analysis Plan by Environmental Medium

Medium	SNOW					
Purpose	Measure of direct atmospheric contaminant loading, and in many cases, 90% of the annual precipitation, interannual variability					
Frequency	Annually; 14 sites in 8 core parks, and additional snow-only sites for elevational transect					
Samples	Inorganic Integrated vertical snowpack profile Single Teflon Bag, 6 liters of snow = 2 liters of water; Shipped with dry ice and blue ice to USGS-CO					Organic Integrated vertical snowpack profile 6 Teflon Bags, 20 liters of snow each = 42 liters of water; Shipped with dry ice and blue ice to WRS
Sample Processing	Filtration thru 0.45µm	Unfiltered, acidified	Unfiltered	Filtered thru GF/C (1.2µm)	Filtration thru GF/F (0.7µm)	Sorbant ASE
Analytes	Filtered, acidified: Ca, Mg, Na, K (IC) Filtered: NO ₃ , SO ₄ , Cl, NH ₄ (IC) DOC (IR) Unfiltered: specific conductance, pH, ANC	Metals: Cd, Cu, Pb, Ni, V, Zn, plus additional metals listed in Table 2.2.1 (ICP- MS)	Hg (oxidation, purge and trap; CVAFS)	Spheroidal carbonaceous particle analysis	Total particulate C and N (EPA Method 440.0)	Target SOC analytes (GC/MS)
Laboratory	USGS-CWSC	USGS-NRP Boulder	USGS- WWSC	ECRC	CBL	SEC

Medium	FISH					
Purpose	Direct measure of food web impacts, bioaccumulation and link to the terrestrial component; evaluation of health and condition effects					
Frequency	Once per site: 4 to 6 sites (2 to 3 core parks) per year					
Samples	~30 fish/lake (3 fish from each of 5 age classes, from both sexes, from a single species); samples frozen on dry ice in field, shipped to WRS, then distributed to appropriate lab.					
	Condition factors	Hematology/ Physiology	Histopathology (gills, kidney, liver, spleen, gonads)	Whole fish tissue		Livers and fillets (from up to 10 additional fish collected for metals analysis)
Sample Processing		Blood obtained by caudal vein puncture, plasma collected and frozen in the field	Organs preserved in 10% neutral buffered formalin	Liquid N ₂ homogenization; subsample solvent extracted (ASE) for SOC analyses		Homogenization, freeze drying, microwave digestion
Analytes	Weight, fork length, Macroscopic health index; ages from scales and otoliths	Hematocrits, plasma, cortisol, glucose, sex hormones, and vitellogenin	Evaluation of pathological changes, macrophage aggregate analysis; and reproductive state	Hg (Direct Hg Analyzer)	Target SOC analyses (GC/MS)	Metals: Cd, Cu, Pb, Ni, V, Zn (ICP/MS)
Laboratory	In field, and OSU-Fish	In field, and OSU-Fish	OSU-Fish	WRS	SEC	USGS-NRP Boulder

Medium	LICHENS			CONIFER NEEDLES and LICHENS		SUBSISTENCE NATIVE FOOD (MOOSE)		
Purpose	Direct measure of food web impacts and bioaccumulation; used primarily to evaluate N, S, and heavy metal impacts			Measure of ecosystem exposure, large “n” for statistical comparisons within and among sites, parks, regions, and elevations		Direct measure of food sources (moose) used by native people		
Frequency	Once per site: from 12 sites in 8 core parks in 2004			Once per site: Elevational transects (~5 sites/park) from 8 core (2004) and 12 secondary parks (2005). Pilot study (4 sites) in SEKI in 2003		Once: Alaska only, 3 moose collected		
Samples	6 lichen samples collected per site (3 samples each of 2 species); ~20 g dry weight of material for each sample; Shipped with ice to WRS			One lichen species and second-year needles from one conifer species at 5 sites at different elevations per park; 3 samples collected at each core park site, 1 sample collected at each secondary park site; Shipped with ice to WRS		Samples provided to Parks by native hunters; Shipped with dry ice to WRS		
Sample Processing	Ground thru 20 mesh, then oven dried at 65°C to constant weight			SOCs: Extraction using ASE N: Ground thru 20 mesh, then oven dried at 65°C to constant weight		Hg & SOCs: Liquid N ₂ homogenization; subsample solvent extracted (ASE) for SOC analyses Metals: Homogenization, freeze drying, microwave digestion		
Analytes	S	Metals: Cd, Cu, Pb, Ni, V, Zn (ICP-MS)	Hg (Direct Hg Analyzer)	N	Target SOC analytes (GC/MS)	Hg (Direct Hg Analyzer)	Target SOC analytes (GC/MS)	Metals: Cd, Cu, Pb, Ni, V, Zn (ICP-MS)
Laboratory	UMNRAL	USGS-NRP Boulder	WRS	UMNRAL	SEC	WRS	SEC	USGS-NRP Boulder

Medium	WATER		LAKE SEDIMENT				
Purpose	System characterization; standard water quality information	Hydrophilic current-use chemicals and SOC _s	Historic trends (~150 years) of contaminant loading to catchments				
Frequency	Once per site: 4 to 6 sites (2 to 3 core parks) per year	Once per site: 4 to 6 sites (2 to 3 core parks) per year	Once per site: 4 to 6 sites (2 to 3 core parks) per year				
Samples	Inorganic 2 L water sample, 2 60-ml syringe samples; shipped with ice to WRS	Organic ~50 L water sample filtered <i>in situ</i> ; filters shipped with dry ice to WRS	Sediment cores, sectioned in 0.5 cm intervals to 10 cm, then 1.0 cm intervals to 30 cm.; shipped with ice packs to WRS				
Analytes	<i>In situ</i> : specific conductance, DO, temperature, turbidity Filtered: Ca, Mg, Na, K, Zn, Se (AAS), NO ₃ , SO ₄ , Cl, (IC) SiO ₂ , NH ₄ (AA), DOC (IR), color Unfiltered: TN, TP (FIA), ANC, TSS Syringe "closed system" samples: pH, DIC	Target SOC analytes, particulate and dissolved phases (GC/MS)	Dating profiles (²¹⁰ Pb, ¹³⁷ Cs, ²⁴¹ Am)	Spheroidal carbonaceous particle analysis	%moisture, Ash-free dry weight (loss-on-ignition) or total organic carbon Hg (Direct Hg Analyzer)	Target SOC analytes (GC/MS)	Metals: Cd, Cu, Pb, Ni, V, Zn (ICP-MS)
Laboratory	WRS	SEC	ERRC	ECRC	WRS	SEC	USGS-NRP Boulder

Abbreviations:

AAS	Atomic absorption spectrophotometry
ASE	Accelerated solvent extraction
CVAFS	Cold vapor atomic fluorescence spectrometry
FIA	Flow injection analysis
GC/MS	Gas chromatography with mass spectrometry
IC	Ion chromatography
ICP-AES	Inductively coupled plasma with atomic emission spectrometry
ICP-MS	Inductively coupled plasma with mass spectrometry
IR	Infrared detection

Laboratories:

Laboratory Abbreviation	Laboratory
CBL	Chesapeake Biological Laboratory, Univ. of Maryland, Solomons, MD
ECRC	Environmental Change Research Centre, University College London, London, UK
ERRC	University Environmental Radioactivity Research Centre, University of Liverpool, Liverpool, UK
OSU-Fish	OSU Kent Laboratory, Corvallis, OR
SEC	Simonich Environmental Chemistry Laboratory, OSU, Corvallis, OR
UMNRAL	University of Minnesota Research Analytical Laboratory, St. Paul, MN
USGS-NRP Boulder	National Research Program Laboratory, Boulder, CO
USGS-CWSC	USGS Colorado Water Science Center, Alpine Hydrologic Research Team, Lakewood, CO
USGS-WWSC	USGS Wisconsin Water Science Center, Mercury Research Laboratory, Middleton, WI
WRS	Willamette Research Station Analytical Laboratory, USEPS, Corvallis, OR